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PERFORMANCE EVALUATION OF BLACK COTTON SOIL BY 5% SUGARCANE BAGASSE ASH AND RECRON 3s FIBRE

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ABSTRACT

Expansive soils have the tendency to undergo volume change behaviour and cause huge uplift pressures and upheaval of structures based on it due to presence of moisture. In most of cases, practically it is not possible to avoid expansive soil and replacement of soil by any material or soil, in large area of expansive soil. The black cotton soil is type of expansive soil. For the treatment of black cotton soil, various materials add in black cotton soil. These materials work as admixture in black cotton soil and stabilize the soil. In this research work, black cotton soil (expansive soil) is stabilized by using 5% sugarcane bagasse ash (SCBA) and different percentage of Recron 3s from 0.5% to 2.5% weight of black cotton soil mix specimen of 5% SCBA. The liquid limit, plastic limit, plasticity index, differential free swell index, swelling pressure, standard proctor test, California bearing ratio and unconfined compressive strength tests were performed in laboratory to study the behaviour of black cotton soil.

Keywords *- **Black Cotton Soil, California Bearing Ratio, 5% Sugarcane Bagasse Ash, Recon 3s Fibre, Standard Proctor Test, Unconfined Compressive Strength Test***

I. INTRODUCTION

Soil was utilized as a building material since ancient time but it is found that it is poor in mechanical properties. It has pull out a challenge for civil engineers to enhance its properties depending upon requirement which varied from place to place. Various scientist and research tried to improve the properties of black cotton soil by using different admixtures and waste materials. **Noorahemd A. H. et. al.** studied the stabilization of black cotton soil using coir + pith and bagasse ash as stabilizer. The CBR test and other test were performed for study the behaviour of black cotton soil. From soaked CBR, it is observed that CBR value is increasing 1.90% to 4.04% and similarly, form unsoaked CBR value, it is observed that CBR value is increasing from 2.38% to 7.91% of soil mixed with varying percentage of coir fibre bagasse ash. **M. Bagra** performed experiment for stabilization of black cotton soil with reinforcement of jute fibre. From test results, it is observed that the fibre is increasing CBR and other properties of black cotton soil. Hence, this experimental study is done for black cotton soil which is locally available in **Kota** region.

II. Experimental Investigations

For determination and study the behaviour of black cotton soil with different percentage of sugarcane bagasse ash following tests were performed.

2.1 Engineering Properties of BCS, BCS + 5%SCBA

The following engineering properties are determined by laboratory experiments as shown in Table 1

Table 1 – Engineering Properties of Black Cotton Soil, BCS + 5% SCBA

Properties	Black Cotton Soil (BCS)	BCS + 5% SCBA
Liquid Limit (%)	54.88	58.74
Plastic Limit (%)	26.64	28.95
Plasticity Index (%)	27.94	29.80
Differential Free Swell (%)	55.00	47.62
Swelling Pressure (kg/cm^2)	0.90	1.50
MDD (gm/cc)	1.708	1.740
OMC (%)	18.2	16.4
IS Classification	CH	CI to CL

2.2 Standard Proctor Test

This test is performed for determining the maximum dry density and optimum moisture content in soil sample. This test was performed according IS 2720 (Part – 9) – 1971. The test results are shown in Table 2.

Table 2 – Standard Proctor Test for BCS + 5%SCBA with Mix Specimen of Fibre

Specimen Name	MDD (gm/cc)	OMC (%)
BCS	1.708	18.2
BCS + 5.0% SCBA	1.740	16.4
BCS + 5.0% SCBA + 0.5% Fibre	1.744	15.2
BCS + 5.0% SCBA + 1.0% Fibre	1.748	14.2
BCS + 5.0% SCBA + 1.5% Fibre	1.726	15.6
BCS + 5.0% SCBA + 2.0% Fibre	1.700	17.6
BCS + 5.0% SCBA + 2.5% Fibre	1.694	19.2

From Table 2, it has been observed that the black cotton soil (clay) + 5% SCBA mix specimen is having 1.740 gm/cc maximum dry density. With increasing the percentage of fibre in black cotton soil + 5% SCBA, the maximum dry density of mix specimen is increased with increasing the percentage of fibre till 1.0%. After 1.0% fibre, the value of maximum dry density is decreased by increasing the percentage of fibre and it is decreased up to 2.64%. The graphical presentation of percentage variation in MDD for BCS + 5% SCBA mix specimen of fibre is shown in fig. 1.

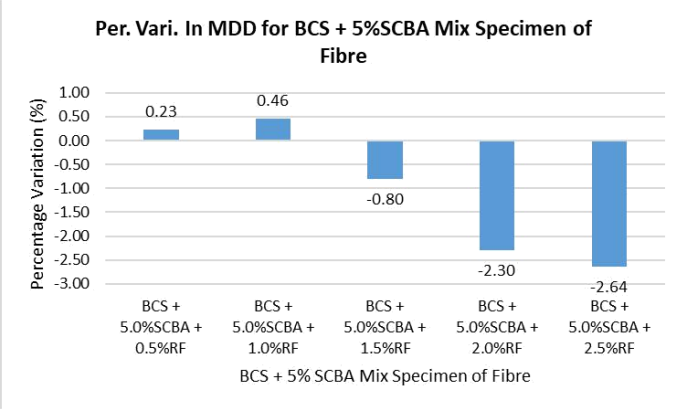

Fig. 1 – Percentage variation in MDD for BCS + 5% SCBA mix specimen of fibre

2.3 California Bearing Ratio Test

The California bearing ratio test (usually abbreviated as CBR test) is an adhoc penetration test developed by the California state highway department of USA for the evolution of subgrade strength of roads and pavements. This test was performed according IS 2702: (Part – 16) – 1979. The test results of unsoaked CBR are shown in Table 3.

Table 3 – CBR Test Results Obtained for BCS and Mix Specimen of SCBA

Specimen Name	CBR Value (%)	% Variation
BCS	9.56	-
BCS + 5.0% SCBA	10.15	6.11
BCS + 5.0% SCBA + 0.5% Fibre	10.88	7.19
BCS + 5.0% SCBA + 1.0% Fibre	12.26	20.86
BCS + 5.0% SCBA + 1.5% Fibre	10.22	0.72
BCS + 5.0% SCBA + 2.0% Fibre	9.64	-5.04
BCS + 5.0% SCBA + 2.5% Fibre	8.47	-16.55

Note -ve sign is showing decrease from BCS

From Table 3, it has been observed that the value of CBR for black cotton soil specimen is 9.56%. When 5% SCBA is mixed in black cotton soil, the value of CBR is increasing up to 6.11%. Further when adding fibre in mix specimen of BCS + 5% SCBA, by increasing the percentage of fibre up to 1.0%, the value of CBR increases by 20.86%. Hence, it is concluded that value of CBR increases with increasing percentage of fibre till 1.0% in black cotton soil + 5% SCBA mix specimen. The graphical presentation of percentage variation in CBR value of black cotton soil + 5% SCBA mix specimen of fibre is shown in fig. 2.

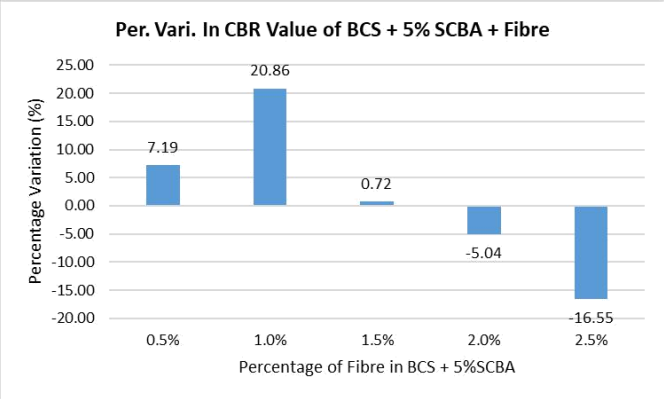

Fig. 2 – Percentage variation in CBR value of BCS + 5% SCBA mix specimen of fibre

2.4 Unconfined Compressive Strength Test

The purpose of this test is to obtain a quantitative value of compressive and shearing strength of clay soils in an undrained state. This test was performed according IS 4332 (Part – 5) – 1970. The test results are shown in Table 4 and from Table 4, it has been observed that the UCS of black cotton is determined 18.14 N/cm^2 and shear strength is 9.07 N/cm^2. Similarly, in case of BCS + 5% SCBA mix specimen, the UCS value is determined 20.50 N/cm^2 and shear strength 10.25 N/cm^2. By adding fibre with varying percentage of fibre in BCS + 5% SCBA, the UCS value is increased up to 23.31 N/cm^2 and shear strength 11.66 N/cm^2. Further increasing the percentage of fibre in mix of BCS + 5% SCBA, the value of UCS and shear strength is decreasing up to 16.57%. The graphical presentation of percentage variation of UCS value is shown in fig. 3.

Table 4 – UCS Test Results Obtained for BCS, Mix Specimen of SCBA

Specimen Name	Unconfined Compressive Strength q_u (N/cm^2)	% Variation for Compressive Strength (%)	Shear Strength C_u (N/cm^2)	% Variation in Shear Strength C_u (%)
BCS	18.14	-	9.07	-
BCS + 5.0% SCBA	20.50	13.03	10.25	13.03
BCS + 5.0% SCBA + 0.5% Fibre	21.07	2.80	10.54	2.80
BCS + 5.0% SCBA + 1.0% Fibre	23.31	13.73	11.66	13.73
BCS + 5.0% SCBA + 1.5% Fibre	20.06	-2.13	10.03	-2.13
BCS + 5.0% SCBA + 2.0% Fibre	18.74	-8.57	9.37	-8.57
BCS + 5.0% SCBA + 2.5 Fibre	17.10	-16.57	8.55	-16.57

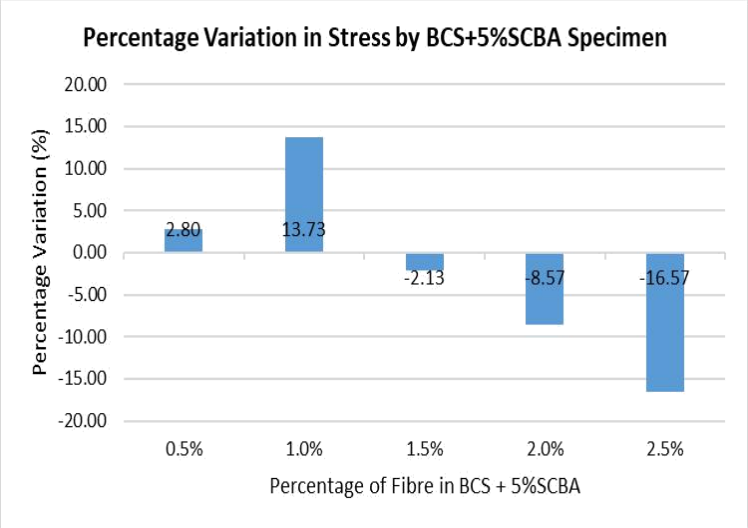

Fig. 3 – Percentage variation in UCS value of BCS + 5% SCBA mix specimen of fibre

III. Discussion on Test results

The black cotton soil changes it is behaviour due to sugarcane bagasse ash. The sugarcane bagasse ash is low plasticity material and black cotton soil inorganic clay of High plasticity. The plasticity of black cotton soil decreases with increasing the amount of SCBA. The maximum dry density and optimum moisture content is 1.748 gm/cc and 18.2% determined at 1.0% fibre mixed in BCS + 5% SCBA but when more than 1.0% fibre is added in black cotton soil + 5% SCBA, the maximum dry density and optimum moisture content are decreased up to 1.694 gm/cc and 19.2% respectively. It is also observed that when up to 1.0% fibre is mixed in black cotton soil + 5% SCBA mix specimen, the UCS and CBR value increasing.

IV. Conclusions

The black cotton soil is inorganic clay of high plasticity soil. with 5% percentage of SCBA, the black cotton soil changes its behaviour from inorganic clay of high plasticity soil to inorganic clay of low plasticity (CH to CL) and the plasticity index of black cotton soil is increased 6.67%. The maximum dry density of black cotton soil + 5%SCBA is 1.740 gm/cc determined but when 1.0% fibre is mixed in black cotton soil + 5% SCBA, the maximum dry density of black cotton soil + 5% SCBA mix specimen is increasing up to1.748 gm/cc.
Hence, the density is improved and fibre can be used to improve the shear strength of black cotton soil with 5% SCBA. From CBR test, it is also observed that the 1.0% fibre mix specimen of black cotton soil + 5% SCBA, increasing CBR value by 20.86%. Similarly, in case of UCS test, the shear strength is increased up to 13.73% from UCS value of BCS.

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